VERIFICATION OF TRANSLATION

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declare that I am well acquainted with both the Japanese and English languages, and that the attached is a literal translation, to the best of my knowledge and ability,, of

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[Title of the Invention] MAGNETIC RESONANCE IMAGING APPARATUS

[Claim for a Patent]

[Claim 1] A magnetic resonance imaging apparatus, comprising the steps of:

mounting a reception coil on an object region of a subject arranged in a static magnetic field;

applying a radio-frequency magnetic field and a gradient magnetic field to the subject; and

receiving a magnetic resonance signal generated from the subject by the reception coil, thereby obtaining images of the subject, the magnetic resonance imaging apparatus comprising:

a couch for moving the subject arranged in the static magnetic field in a horizontal direction in a horizontal plane and in a vertical direction perpendicular to the horizontal plane; and

a couch controlling means for moving the couch so that the object region is caused to coincide with a center of the static magnetic field and the gradient magnetic field on the basis of a location of the object region obtained from the images of the subject.

[Claim 2] A magnetic resonance imaging apparatus according to claim 1, wherein

prior to alignment of the object region, the couch is generally aligned so as to align the object region to the vicinity of the center of the static magnetic field and the gradient magnetic field.

[Claim 3] A magnetic resonance imaging apparatus, comprising the steps of:

mounting a reception coil on an object region of a subject arranged in a static magnetic field;

applying a radio-frequency magnetic field and a gradient magnetic field to the subject; and

receiving a magnetic resonance signal generated from the subject by the reception coil, thereby obtaining images of the subject, the magnetic resonance imaging apparatus comprising:

a couch for moving the subject arranged in the static magnetic field in a horizontal direction in a horizontal plane and in a vertical direction perpendicular to the horizontal plane;

a detection means for detecting a location of the reception coil mounted on the object region; and

a couch controlling means for generally moving the couch so that the reception coil is caused to coincide with an optimum area of the static magnetic field and the gradient magnetic field on the basis of the location of the reception coil detected by the detection means.

[Claim 4] A magnetic resonance imaging apparatus according to claim 3, wherein the couch controlling means moves the couch so that the object region is caused to coincide with a center of the static magnetic field and the gradient magnetic field on the basis of a location of the object region obtained from the images of the subject.

[Claim 5] A magnetic resonance imaging apparatus according to claims 1 to 4, wherein

the couch comprises:

a top plate on which the subject is mounted;

a horizontally mounting means for moving the top plate to the horizontal direction in proportion to an amount of horizontal movement transmitted from the couch controlling means; and

a vertical moving means for moving the top plate to the vertical direction in proportion to an amount of vertical movement transmitted from the couch controlling means.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a magnetic resonance imaging apparatus (open-type MRI) that has an open magnet gantry.

[0002]

[Prior Art]

Earlier open-type MRI systems include a vertical magnetic field type MRI system (MRI system with open access to patient image volume), featuring open access (releasibility) to the patient photographic area, as disclosed, for example, in USP 4,829,252.

[0003]

In an MRI system featuring good open access, such as the above-noted vertical magnetic field type of open MRI system or a tubular type MRI system of the past with a short axis and large diameter, the patient couch is moved front and back and to the left and right at a uniform height with respect to the patient transport axis when acquiring images. In this case, because there is good magnetic field uniformity at the center of a gradient magnetic field and a static magnetic field, if images of the region of treatment of the patient are acquired at the center position of the magnetic field, high-quality images of the region of treatment are obtained.

[0004]

When operating the above-noted type of open MRI system as an interventional apparatus, in particular the region (location) of treatment is often not large, but limited to a specific area.

[0005]

[Problems to be Solved by the Invention]

However, when the region of treatment is limited to a specific area, even if the patient couch is moved within a horizontal plane with respect to the patient transport axis at a uniform height when imaging, it was either extremely difficult or impossible to position the region of treatment at the center of the gradient magnetic field and static magnetic field in three dimensions.

[0006]

For this reason, the obtained images exhibited a great deal of image distortion, image non-uniformities, and fat artifacts, making it difficult to use the images in treatment.

[0007]

Accordingly, it is an object of the present invention to provide a magnetic resonance imaging apparatus which enables quick positioning of the region of treatment or diagnosis at the center of the gradient magnetic field and static magnetic field, and enables the acquisition of highly precise, high-quality images, with reduced image distortion, non-uniformities, and fat artifacts.

[0008]

[Means for Solving the Problems]

In order to solve the above-noted problems to attain the object, the magnetic resonance imaging apparatus according to the present invention is constituted as follows: According to a first aspect of the present invention, the magnetic resonance imaging apparatus comprises the steps of: mounting a reception coil on an object region of a subject arranged in a static magnetic field; applying a radio-frequency magnetic field and a gradient magnetic field to the subject; and receiving a magnetic resonance signal generated from the subject by the reception coil, thereby obtaining images of the subject, the magnetic resonance imaging apparatus comprising: a couch for moving the subject arranged in the static magnetic field in a horizontal direction in a horizontal plane and in a vertical direction perpendicular to the horizontal plane; and a couch controlling means for moving the couch so that the object region is caused to coincide with a center of the static magnetic field and the gradient magnetic field on the basis of a location of the object region obtained from the images of the subject.

[0009]

According to the present invention, the couch controlling means moves the couch so as to move the subject in the horizontal direction in the horizontal plane and in the vertical direction perpendicular to the horizontal plane on the basis of the location of the object region obtained from the images of the subject, and causes to coincide the object region of the subject with the static magnetic field and the gradient magnetic field. As the result, it is possible to obtain highly precise, high-quality images, with reduced image distortion, non-uniformities, and fat artifacts.

[0010]

Further, according to a third aspect of the present

invention, the magnetic resonance imaging apparatus comprises the steps of: mounting a reception coil on an object region of a subject arranged in a static magnetic field; applying a radio-frequency magnetic field and a gradient magnetic field to the subject; and receiving a magnetic resonance signal generated from the subject by the reception coil, thereby obtaining images of the subject, the magnetic resonance imaging apparatus comprising: a couch for moving the subject arranged in the static magnetic field in a horizontal direction in a horizontal plane and in a vertical direction perpendicular to the horizontal plane; a detection means for detecting a location of the reception coil mounted on the object region; and a couch controlling means for generally moving the couch so that the reception coil is caused to coincide with an optimum area of the static magnetic field and the gradient magnetic field on the basis of the location of the reception coil detected by the detection means.

[0011]

According to the third aspect of the present invention, when the detection means detects a location of the reception coil mounted on the object region, the couch controlling means automatically generally moves the couch so as to coincide the reception coil with an optimum area of the static magnetic field and the gradient magnetic field on the basis of a location of the reception coil detected by the detection means.

[0012]

[Preferred Embodiment]

Hereinafter, embodiments of the present invention will be described with reference to the drawings.

[0013]

<First Embodiment>

Fig. 1 shows a perspective outer (aerial) view of an open-type MRI apparatus according to a first embodiment of the invention. In Fig. 1, the arrow A indicates a front direction as seen from the front of the MRI apparatus, the arrow B indicates a side direction, and the arrow C indicates a top direction.

[0014]

A main gantry 1 (hereinafter generally referred to as the magnet gantry 1) has within it a static magnetic field magnet, a gradient magnetic field coil, and an excitation (RF) coil for use with respect to the entire body of a patient. A patient couch 2 can move freely over a floor surface 13, and a tabletop 6, on which a patient P is placed, is mounted to a top part of the patient couch 2.

[0015]

The magnet gantry 1 is of spherical shape and, seen from the direction of arrow A, has a space 3, this space having a width such that it is possible to insert the patient couch 2 into the center part of the magnet gantry 1. The center of the magnet gantry 1 has a spherically shaped inner space 5, which houses the patient couch 2, including the tabletop 6, and is of sufficient size as to allow the rotation of the patient couch 2 in an arbitrary direction (for example, in a horizontal direction).

[0016]

The patient couch 2 is provided with a rotational drive mechanism (not shown in Fig. 6) for the purpose of rotationally driving the tabletop 6, onto which the patient P is placed, at least 90 degrees within the horizontal plane after the patient

couch 2 is placed in the center of the inner space 5.

[0017]

An access port 7 through which the inner space 5 communicates with the outside of the magnet gantry 1 is provided in the side part of the magnet gantry 1 as seen from the direction of the arrow B. A similar access port is also provided on the opposite side of the inner space 5.

[0018]

The access port 7 allows passage of part of the tabletop 6 when the patient couch 2 is housed within the inner space 5, and is of sufficient width to allow the patient P that is disposed horizontally to pass through the center part on both sides of the magnet gantry, so as to position the region of diagnosis or region of treatment at the center of the magnet.

[0019]

According to the above-noted configuration, it is possible for a physician, for example, to enter the inner space 5 via the space 3 formed in the magnet gantry 1, and possible for a physician, for example, to approach the patient couch 2 onto which the patient P is placed, from the side.

[0020]

Fig. 2 shows a system block diagram of the MRI apparatus according to the first embodiment of the present invention, and Fig. 3 shows the arrangement of the static magnetic field magnet and the gradient magnetic field coil. In Fig. 2, the cross-section of the magnet gantry 1 as seen from the frontal direction thereof is shown. In this case, by placing the patient couch 2, inserted via the space 3, into the inner space

5 of the magnet gantry 1, and rotating the tabletop 6 in the horizontal plane at 90 degrees by means of the rotational drive mechanism of the patient couch 2, a body axis of the patient P is aligned in the direction of the access port 7.

[0021]

In the above-condition (with the patient P in a condition that enables image acquisition), or before and after this condition, a reception coil 19 or a transmitting/receiving coil is attached at, for example, a chest area of the patient P.

[0022]

The patient couch 2 can move the tabletop 6 on which the patient is mounted, forward and back, to the left and right (horizontal directions) and up and down (vertical directions), and is formed by a patient couch base 2a, a horizontal movement screw box 2c, which has a horizontal movement mechanism for the purpose of moving the tabletop 6 in a horizontal direction, and a linking section 2b, which links the base 2a and the horizontal movement screw box 2c of the patient couch 2 and which has a vertical movement mechanism for the purpose of moving the tabletop 6 up and down. In Fig. 2, the center O indicates the center of the static magnetic field and the center of the gradient magnetic field. The horizontal movement mechanism and vertical movement mechanism will be described below.

[0023]

A static magnetic field magnet 21, as shown in Fig. 3, is disposed along the substantially spherical inner space 5, and is formed by a coil bundle made of either a superconductor or a conventional conductor, through which a circulating current passes, resulting in a magnetic field that is uniform with respect to the body axis of the patient P (Z direction)

being applied to the patient P.

[0024]

A gradient magnetic field coil 23 is formed by an X-direction gradient magnetic field coil 23x, a Y-direction gradient magnetic field coil 23y, and a Z-direction gradient magnetic field coil 23z, these coils being driven by a gradient magnetic field power supply 17. These gradient magnetic field coils apply gradient magnetic fields Gx, Gy, and Gz, the magnetic field intensity of which varies linearly, in the X and Y directions within a desired cross-section of the patient P, and in the Z direction, which is perpendicular to the X and Y directions.

[0025]

With this arrangement, because the static magnetic field magnet 21 is provided along the inner space 5, the coil pattern of the static magnetic field magnet 21 is spherical, enabling enhancement of the uniformity of the static magnetic field developed by the static magnetic field magnet.

[0026]

The MRI apparatus also has a system controller 14, a transmitting/receiving (T/R) unit 15, a patient couch controller 16, a gradient magnetic field power supply 17, a reconstruction apparatus 18a, and a display apparatus 18b. The T/R unit 15, under control from the system controller 14, generates a radio-frequency magnetic field with respect to the patient P by applying a radio-frequency signal to the T/R coil 19, receiving from the reception coil 19 a magnetic resonance signal generated from the patient P with the application of a static magnetic field, a gradient magnetic field and a radio-frequency magnetic field, amplifying and detecting the

received signal, and then A/D converting and sending the signal to the reconstruction apparatus 18a.

[0027]

The reconstruction apparatus 8a performs image configuration processing, including Fourier transformation, with respect to data input to it from the T/R unit 15. The display apparatus 18b displays a cross-sectional image of the patient P that was reconstructed by the reconstruction apparatus 18a.

[0028]

The patient couch controller 16, under the control of the system controller 14, outputs movement amount information to the patient couch 2, this information indicating an amount of horizontal movement of the tabletop 6 and an amount of up and down movement of the tabletop 6.

[0029]

The patient couch controller 16 outputs movement amount information to the patient couch 2 for the purpose of moving the patient couch 2 so that the center of the region of imaging (region of diagnosis or region of treatment) of the patient P is caused to coincide with the center O of the static magnetic field and center of the gradient magnetic field. The patient couch 2, in response to the movement amount information from the patient couch controller 16, moves the tabletop 6 in the horizontal and vertical directions, using the horizontal movement mechanism and vertical movement mechanism.

[0030]

(Horizontal movement mechanism)

Fig. 4 shows a horizontal movement mechanism of the patient couch that is provided in the MRI apparatus according to the first embodiment. Fig. 4(a) provides a rear view of a horizontal movement screw box and the horizontal movement mechanism that is provided on the tabletop. Fig. 4(b) provides a side view of the horizontal movement screw box and the horizontal movement mechanism that is provided on the tabletop. The horizontal movement mechanism 24 is described below with reference to Fig. 4.

[0031]

Referring to Fig. 4(a), on the rear side of the tabletop 6 are formed two rows of front-to-back movement screw grooves 25, on the left and right, for the purpose of moving the tabletop 6 forward and back, and left-to-right movement screw grooves 27, disposed between the tow rows of front-to-back movement screw grooves 25, for the purpose of moving the tabletop 6 to the left and right.

[0032]

Inside the horizontal movement screw box 2c are provided front-to-back movement screws 29, which are disposed so as to mesh with the front-to-back movement screw grooves 25, and a left-to-right movement screw 33, which is disposed so as to mesh with the left-to-right movement screw grooves 27. The front-to-back movement screw 29 and the left-to-right movement screw 33 are mounted to a shift 31.

[0033]

According to a horizontal movement mechanism configured as noted above, when movement amount information that indicates an amount of horizontal movement is sent from the patient couch

controller 16, the screws 29 and 33 rotate in response to this amount of horizontal movement sent from the patient couch controller 16. For this reason, the screw grooves 25 and 27 that mesh with the screws 29 and 33 move, thereby causing the tabletop 6 to move within a horizontal plan (front-to-back and left-to-right), in response to the amount of horizontal movement.

[0034]

(Vertical movement mechanism)

Next, the vertical movement mechanism of the patient couch will be described. Fig. 5 shows the vertical movement mechanism of the patient couch that is provided in the MRI apparatus according to the first embodiment. As shown in Fig. 5, a vertical movement mechanism 34, which causes the tabletop 6 to move up and down, is provided on the tabletop 2.

[0035]

The vertical movement mechanism 34 is formed by a hydraulic cylinder 34a provided in the linking section 2b, a first holding section 35a, which is mounted to one end of the hydraulic cylinder 34a and which is provided in the patient couch base 2a, and a second holding section 35b, which is mounted to the other end of the hydraulic cylinder 34a and which is provided in the horizontal movement screw box 2c. The hydraulic cylinder 34a causes the horizontal movement screw box 2c to move up and down, with respect to the position of the patient couch base 2a, in response to hydraulic pressure.

[0036]

According to the vertical movement mechanism 34 configured as noted above, when an amount of movement

information indicating the amount of vertical movement is sent from the patient couch controller 16, the hydraulic cylinder 34a, in response to an amount of vertical movement information from the patient couch controller 16, uses hydraulic pressure to cause the horizontal movement screw box 2c to move up and down, via the second holding section 35, thereby enabling the up and down movement of the tabletop 6.

[0037]

Next, an MRI apparatus having the horizontal movement mechanism 24 and the vertical movement mechanism 34 configured as described above will now be described. Fig. 6 illustrates the positioning of the region of diagnosis of a patient placed in the MRI apparatus according to the first embodiment, so as to cause this region to coincide with the center of the static magnetic field and the gradient magnetic field. Fig. 6(a) shows the condition of the patient before performing positioning of the position of diagnosis with the center of the magnetic field, and Fig. 6(b) shows the condition of the patient after positioning the region of diagnosis with the center of the magnetic field. Fig. 7 is a diagram showing an alignment scan.

[0038]

When performing positioning of the region of diagnosis (or treatment) with the center O of a magnetic field (static or gradient magnetic field), the reception coil 19 or the T/R coil is first attached at the region of diagnosis 30 such as the chest part of the patient 30, as shown in Fig. 6(a). Then, a manual or electric mechanical means is used to approximately align the tabletop 6 to the region of diagnosis 30 of the patient P, so that the region of diagnosis 30 is positioned in the area of the center O of the static magnetic field and gradient magnetic field by approximately positioning the tabletop 6.

[0039]

Next, after approximate positioning of the tabletop 6, to facilitate positioning of the region of diagnosis 30, the T/R unit 15, reconstruction apparatus 18a, and display apparatus 18b shown in Fig. 2 are used to perform a high-speed positioning scan of a 2-dimensional T1W multislice image, in the horizontal plane near the region of diagnosis 30 of the patient P, as shown in Fig. 7, thereby obtaining the multislice images S1 through S5 along the Z direction (body axis of the patient P).

[0040]

Then, clicking an operating means such as a mouse (not shown), a slice image such as S4, which is the closest to the region of diagnosis 30, is selected from the multislice images S1 to S5. Essentially, after performing approximate positioning of the region of diagnosis 30 within the horizontal plane, a multislice image is used to perform Z direction positioning of the region of diagnosis 30.

[0041]

\Additionally, the system controller 14 outputs the position information of the coordinates (x4, y4 and z4) of the selected slice image S4 to the patient controller 16. Then, the patient couch controller 16 calculates the difference (distance) components between the position information (corresponding to the region of diagnosis 30 position) of the slice image S4 that is sent from the system controller 14 and the position information for the center O of the static magnetic field and the gradient magnetic field, and then controls the patient couch 2 so as to move the tabletop 6 by the calculated distance difference components.

[0042]

When this is done, the horizontal movement mechanism 24 and the vertical movement mechanism 34 move the tabletop 6 in the horizontal and vertical directions, respectively, by the difference components, so that the region of diagnosis 30 is quickly moved so as to coincide with the center O of the static magnetic field and the gradient magnetic field, as shown in Fig. 6(b).

[0043]

Essentially, because the uniformity of the static magnetic field and the linearity of the gradient magnetic field are better the closer the position is to the center O of the static magnetic field and the gradient magnetic field, by moving the patient couch in three dimensions, including vertical movement to that region so as to establish the position of the region of diagnosis 30, it is possible to obtain highly precise, high-quality images, with reduced image distortion, non-uniformities, and fat artifacts.

[0044]

Additionally, by moving the patient couch 2 up and down immediately before and after diagnosis and treatment, it is possible for a physician or a technician to prepare or provide care to the patient P at an appropriate height.

[0045]

The setting of the position of the region of diagnosis 30 can be done, for example, by the operator pointing to the position 30 from a multislice image from the slice image S1 through the slice image S5, and the position can also be performed automatically by means of image proceeding.

[0046]

Next, another embodiment of the patient couch will be described. Fig. 8 shows the patient couch which includes a tabletop horizontal holding mechanism according to the another embodiment. Fig. 9 is a perspective view showing the tabletop horizontal holding mechanism of Fig. 8. Fig. 10 is a cross-sectional view of the tabletop horizontal holding mechanism of Fig. 8. The tabletop horizontal holding mechanism 35, as shown in Fig. 8, holds the tabletop 6 horizontally when the tabletop 6 is moved forward and back with respect to the patient couch 2.

[0047]

This tabletop couch horizontal holding mechanism 35 has a configuration such as shown in Fig. 9. The horizontal movement screw box 2c has the first holding pin 37a mounted to it, and one end of the first supporting rod 36a and the second supporting rod 36b being mounted to this first holding pin 37a. The other end of the first supporting rod 36a has the second holding pin 37b mounted to it, and the other end of the second supporting rod 36b has the third holding pin 37c mounted to it.

[0048]

Tabletop side grooves 39 are formed along the front-to-back direction on the tabletop 6, the second holding pin 37b and the third holding pin 37c fitting into these tabletop side grooves 39, so that when the tabletop 6 moves forward and back, the tabletop side grooves 39 move so that the second holding pin 37b and the third holding pin 37c slide therein.

[0049]

According to a tabletop horizontal mechanism 35 configured as described above, even if the tabletop 6 moves forward and back with respect to the patient couch 2, the effect of the three holding pins, the first supporting rod 36a, and the second supporting rod 36b is to hold the tabletop 6, so that the tabletop 6 does not tip over. Thus, it is possible to perform works smoothly, without having the patient P tip over.

[0050]

Next, another embodiment of the vertical movement mechanism of the patient couch will be described. Fig. 11 shows the vertical movement mechanism of the patient couch according to another embodiment. Fig. 12 shows a patient couch control system that includes the another embodiment of the vertical movement mechanism for the patient couch.

[0051]

A vertical movement mechanism 40 of the patient couch shown in Fig. 11 is configured as follows: Vertical movement mechanism main units 49 are provided at a head end and at a feet end of a floor surface 47 with respect to the patient P, a hydraulic cylinder 41 being disposed within each of these vertical movement mechanism main units 49.

[0052]

A liner 51, which is mounted to the horizontal movement screw box 2c, is disposed at the top ends of the two vertical movement mechanism main units 49, and this liner 51 is supported at both of its ends by the vertical movement mechanism 40. The tabletop 6 is disposed at the top of the liner 51. The hydraulic cylinders 41 use oil pressure to move the liner up and down.

[0053]

The configuration of the horizontal movement mechanism is that of the horizontal movement mechanism provided in the above-described horizontal movement screw box 2c.

[0054]

According to the vertical movement mechanism 40 configured as described above and shown in Fig. 12, when movement amount information indicating an amount of vertical movement is sent from the patient couch controller 16, the hydraulic cylinders 41 move the liner 51 up and down by means of hydraulic pressure, in response to the amount of vertical movement sent from the patient couch controller 16, thereby enabling up and down movement of the tabletop 6.

[0055]

Because of the double structure, having the liner 51 and the tabletop 6, which is supported by the linear 51 and which moves with respect to the liner 51, there is no tilting over of the tabletop 6. Thus, the patient P is not tilted over, and works can be performed smoothly.

[0056]

<Second Embodiment>

Next, a second embodiment of the present invention will be described. Fig. 13 shows a system block diagram of an MRI apparatus according to the second embodiment of the present invention. In this embodiment, when performing positioning of the region of diagnosis with the center O of the magnetic field (static magnetic field or gradient magnetic field), a manual or motorized mechanical means is used to automatically perform approximate positioning of the tabletop 6.

[0057]

For this reason, the MRI apparatus of the second embodiment has a system controller 14a, a T/R unit 15, a patient couch controller 16a, a gradient magnetic field power supply 17, a position sensing unit 52, a 3-diemnsional position sensor transmitter 53, and a 3-dimensional position sensor receiver 55.

[0058]

As shown in Fig. 13, the reception coil 19 or the T/R coil that is attached to the region of diagnosis of the patient P has the 3-dimensional (or 2-dimensional) position sensor transmitter 53 mounted to it. A 3-dimensional position sensor receiver 55 is mounted, for example, at the center of the linking section 12 (position corresponding to directly above the magnetic field center O).

[0059]

The 3-dimensional position sensor receiver 55 receives position information that is sent from the 3-dimensional position sensor transmitter 53. The position sensing unit 52 accepts the position information of the 3-dimensional position sensor transmitter 53 that was received at the 3-dimensional position sensor receiver 55, and sends this information to the system controller 14a.

[0060]

The system controller 14a sends the position information of the 3-dimensional position sensor transmitter 53 to the patient couch controller 16a. The patient couch controller 16a calculates the difference (distance) components between the

position information of the 3-dimensional position sensor transmitter 53 that was sent from the system controller 14a and the position information of the center O of the static magnetic field and gradient magnetic field and controls the patient couch 2 so as to move the tabletop 6 by the amounts indicated by these difference components.

[0061]

Next, the operation of the MRI apparatus of the second embodiment, configured as described above, will be described. Fig. 14 is an explanatory view showing the operation that the reception coil of the MRI apparatus of the second embodiment is caused to generally coincide with the center of the static magnetic field and gradient magnetic field. Fig. 14(a) is a view showing the condition of the patient P before generally coinciding the reception coil with the center of the magnetic field, and Fig. 14(b) is a view showing the condition of the patient P after having generally coincided with the reception coil to the center of the magnetic field.

[0062]

First, as shown in Fig. 14(a), when position information is sent by the 3-dimensional position sensor transmitter 53, the 3-dimensional position sensor receiver 55 receives this position information sent from the 3-dimensional position sensor transmitter 53, and the position sensing unit 52 detects the position information of the 3-dimensional position transmitter 53 that was received by the 3-dimensional position sensor receiver 55.

[0063]

Next, the patient couch controller 16a calculates the difference (distance) components between the position

information (that is, the center position of the reception coil 19 that is attached to the region of diagnosis 30) of the 3-diemsional position sensor transmitter 53 sent from the system controller 14a and the position information of the center O of the static magnetic field and the gradient magnetic field and, in order to move the tabletop 6 by just these difference components, moves the tabletop 6 by the amounts of movement (difference components) sent from the patient couch controller 16a, thereby coinciding the reception coil 19 to the appropriate position, this being the approximate center O of the magnetic field.

[0064]

In this manner, in the second embodiment, as the reception coil 19 can automatically be caused to coincide generally with the center of the magnetic field, it is possible to reduce the work load on the operator.

[0065]

Additionally, after the reception coil 19 was caused to coincide generally with the center O of the magnetic field, as shown in Fig. 7, it is possible to perform positioning of the region of diagnosis 30 by means of a positioning scan, so that by merely moving the tabletop 6 by the amount of the difference components between this region of diagnosis 30 position and the magnetic field center O, it is possible to quickly move the region of diagnosis 30 to the center O of the magnetic field.

[0066]

Accordingly, it is possible to obtain highly precise, high-quality images, with reduced image distortion, non-uniformities, and fat artifacts. Further, by moving the patient couch up and down immediately before and after diagnosis

and treatment, it is possible for a physician or a technician to prepare or provide care to the patient P at an appropriate height.

[0067]

If an image of the position of the reception coil, which is attached to the patient P, is obtained at a point of time of being removed from the center O of the magnetic field and different from the above-described position sensor, discrimination is facilitated because of the weakness of the magnetic resonance signal. By using this phenomenon, it is possible to perform approximate movement of the tabletop 6 at the point at which the magnetic resonance signal reaches a given point, while repeatedly moving the imaging and horizontal movement of the tabletop 6.

[0068]

Next, a modification of the above-noted embodiment will be described. Fig. 15 shows a patient couch control system in a short-axis, large-diameter magnet or a vertical-field type magnet. The patient couch control system is a variation that is suitable for use in applying the present invention to the MRI apparatus with good open access as used in the past of the tubular, short-axis, large-diameter magnet type.

[0069]

The patient couch control system has a tubular-type short-axis, large-diameter magnet 61 for the static magnetic field, a tubular-type gradient magnetic field coil 63, a patient couch 63, a horizontal movement screw box 2c that has a horizontal movement mechanism, a linear 51, hydraulic cylinders 41 that have a vertical movement mechanism, and a patient couch controller 16. According to the patient couch control system

configured in this manner, it is possible to obtain the same type of effect that is obtained by the above-described first and second embodiments.

[0070]

It is to be noted that the present invention is not limited to the above-described embodiments, and can be embodied as various other variations thereof.

[0071]

[Effects of the Present invention]

As described above, according to the present invention, as the magnetic resonance imaging apparatus enables quick positioning of the region of treatment or diagnosis at the center of the gradient magnetic field and static magnetic field, and enables the acquisition of highly precise, high-quality images, with reduced image distortion, non-uniformities, and fat artifacts.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 shows a perspective outer (aerial) view of an open-type MRI apparatus according to a first embodiment of the invention;

[Fig. 2]

Fig. 2 is a system block diagram showing an MRI apparatus according to a first embodiment of the present invention;

[Fig. 3]

Fig. 3 is an arrangement of a static magnetic field magnet and a gradient magnetic field coil;

[Fig. 4]

Fig. 4 is a view showing a horizontal movement mechanism of a patient couch that is provided in the MRI apparatus according to the first embodiment;

[Fig. 5]

Fig. 5 is a view showing a vertical movement mechanism of the patient couch which is provided in the MRI apparatus according to the first embodiment of the present invention;

[Fig. 6]

Fig. 6 illustrates the positioning of a region of diagnosis of a patient placed in the MRI apparatus according to the first embodiment, so as to cause this region to coincide with a center of the static magnetic field and the gradient magnetic field;

[Fig. 7]

Fig. 7 is a diagram showing an alignment scan;

[Fig. 8]

Fig. 8 is a view showing the patient couch which includes a tabletop horizontal holding mechanism according to another embodiment;

[Fig. 9]

Fig. 9 is a perspective view showing the tabletop horizontal holding mechanism of Fig. 8;

[Fig. 10]

Fig. 10 is a cross-sectional view of the tabletop horizontal holding mechanism of Fig. 8;

[Fig. 11]

Fig. 11 is a view showing the vertical movement mechanism of the patient couch according to the another embodiment;

[Fig. 12]

Fig. 12 is a view showing a patient couch control system that includes the another embodiment of the vertical movement mechanism for the patient couch;

[Fig. 13]

Fig. 13 shows a system block diagram of an MRI apparatus according to a second embodiment of the present invention;

[Fig. 14]

Fig. 14 is an explanatory view showing the operation that a reception coil of the MRI apparatus of the second embodiment is caused to generally coincide with the center of the static magnetic field and gradient magnetic field; and

[Fig. 15]

Fig. 15 is a view showing a patient couch control system in a short-axis, large-diameter magnet or a vertical-field type magnet.

[Description of the Reference Numerals]

1: magnet gantry
2: patient couch
2c: horizontal movement screw box
3: space
5: inner space
6: tabletop
7: access port
12: linking section
13: floor surface
14: system controller
15: T/R unit
16: patient couch controller
17: gradient magnetic field power supply
18a: reconstruction apparatus
18b: display apparatus
19: T/R coil
21: static magnetic field magnet
23: gradient magnetic field coil
24: horizontal movement mechanism
30: region of diagnosis
34: vertical movement mechanism
34a, 41: hydraulic cylinders
35: tabletop horizontal holding mechanism
51: liner
52: position sensing unit
53: 3-diemsnional position sensor transmitter
55: 3-diemsnional position sensor receiver
P: patient
O: center of the magnetic field

[Name of Document] ABSTRACT

[Abstract]

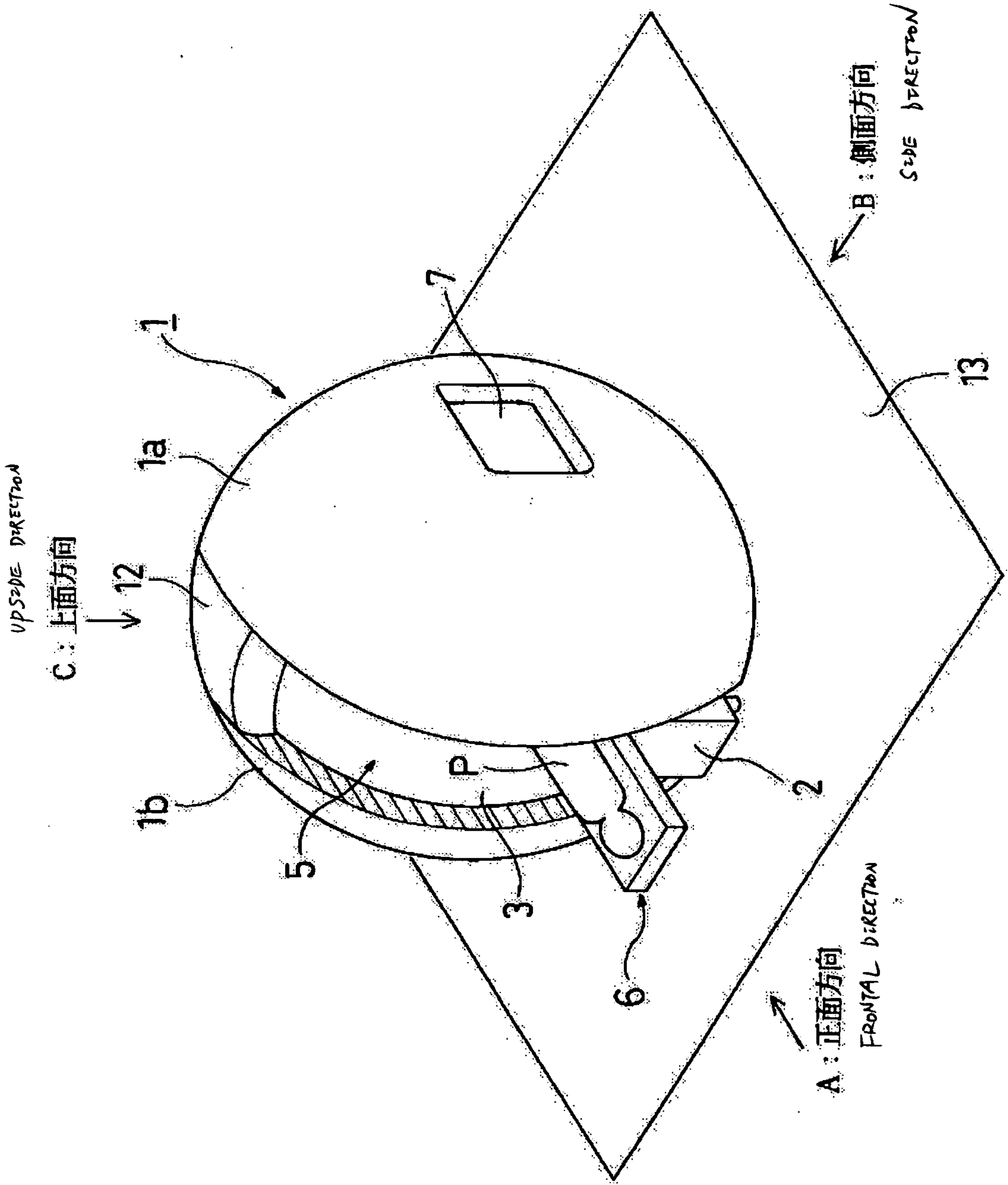
[Object] To acquire highly precise, high-quality images with reduced image distortion, non-uniformities, and fat artifacts.

[Solving Means] A magnetic resonance imaging apparatus comprises the steps of: mounting a reception coil 19 on an object region of a patient 19 arranged in a static magnetic field; applying a radio-frequency magnetic field and a gradient magnetic field to the patient; and receiving a magnetic resonance signal generated from the patient by the reception coil, thereby obtaining images of the patient, wherein a tabletop 6 can move the patient arranged in the static magnetic field in a horizontal direction in a horizontal plane and in a vertical direction perpendicular to a horizontal plane, and a patient couch controlling means 16 moves the tabletop so that the object region is caused to coincide with a center O of the static magnetic field and the gradient magnetic field on the basis of a location of the object region obtained by the images of the patient.

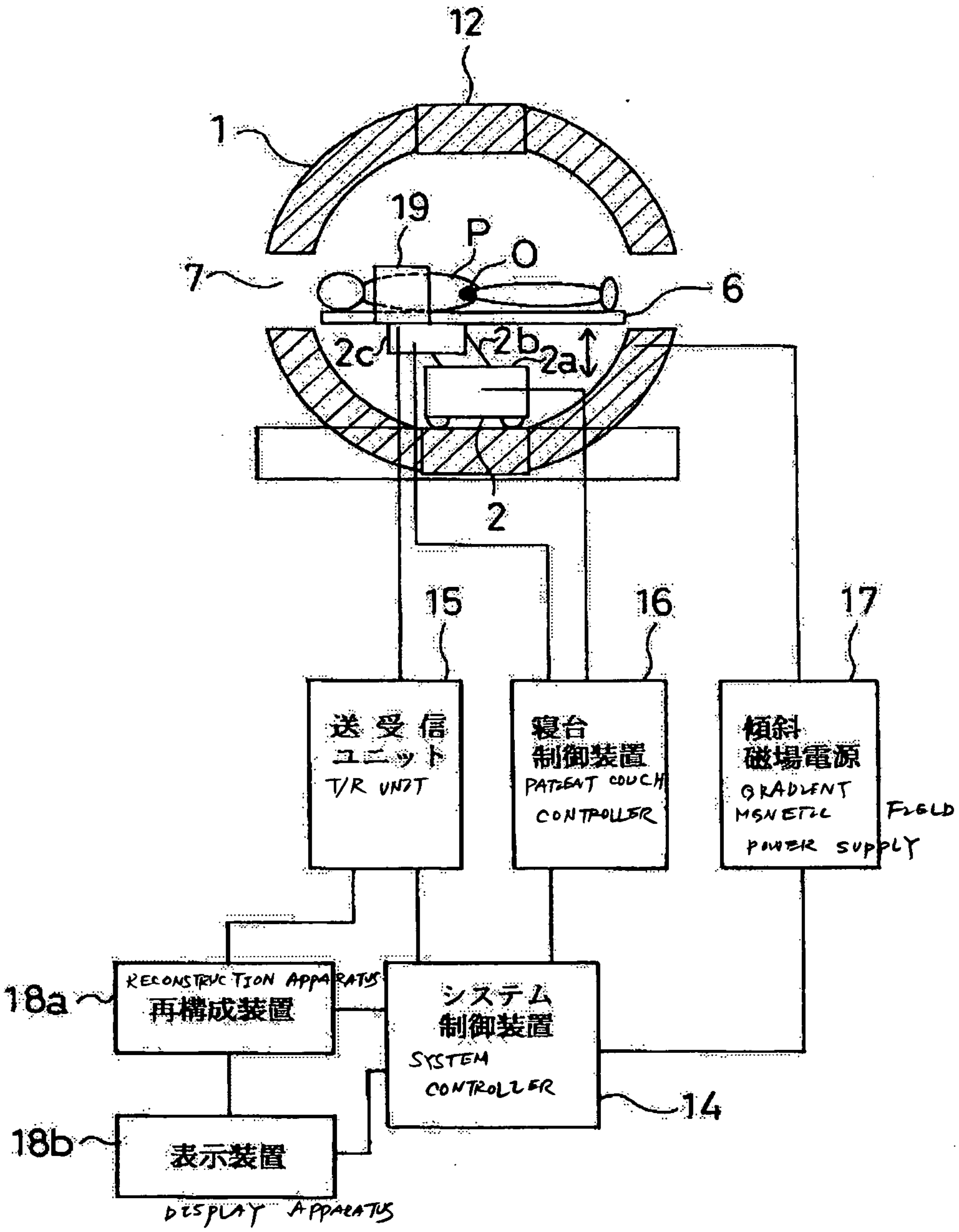
[Selected Figure] Fig. 2

【書類名】　図面
[Name of Document]　DRAWINGS

【図１】
[Fig.1]



【図２】
[Fig.2]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16
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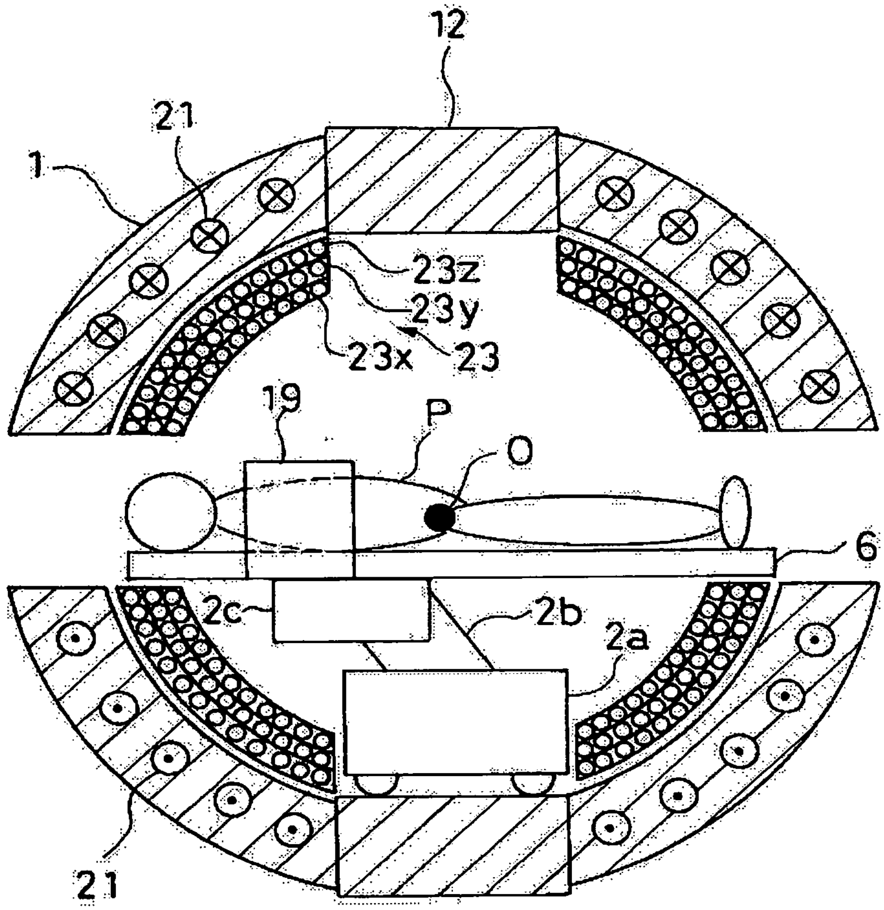
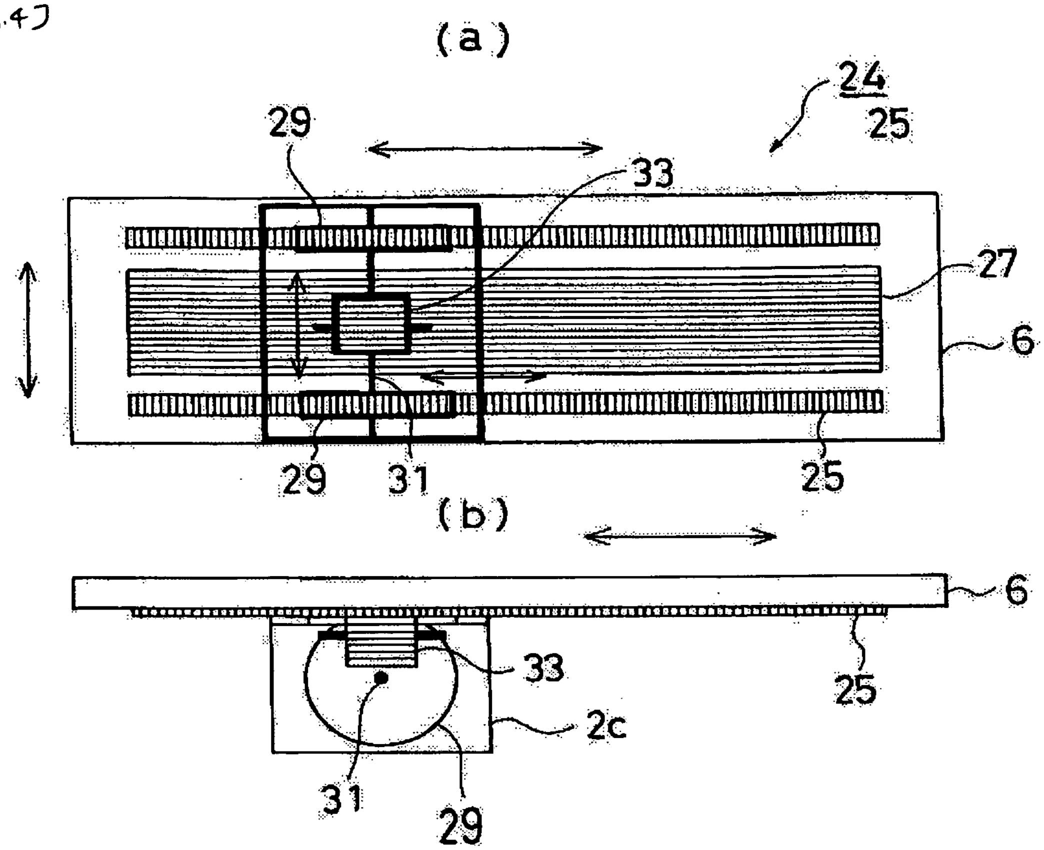
T/R UNIT
寝台
制御装置
PATIENT COUCH
CONTROLLER
傾斜
磁場電源
GRADIENT
MAGNETIC FIELD
POWER SUPPLY
18a
RECONSTRUCTION APPARATUS
再構成装置
システム
制御装置
SYSTEM
CONTROLLER
14
18b
表示装置
DISPLAY APPARATUS

【図３】
[Fig.3]



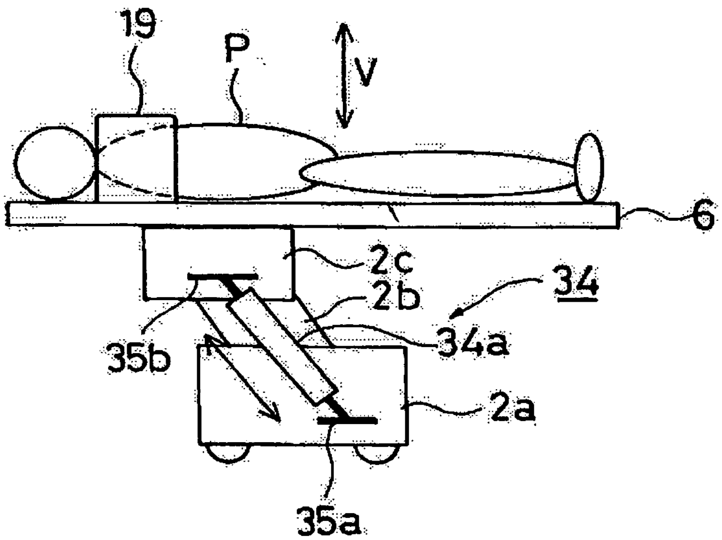
【図４】

[Fig.4]



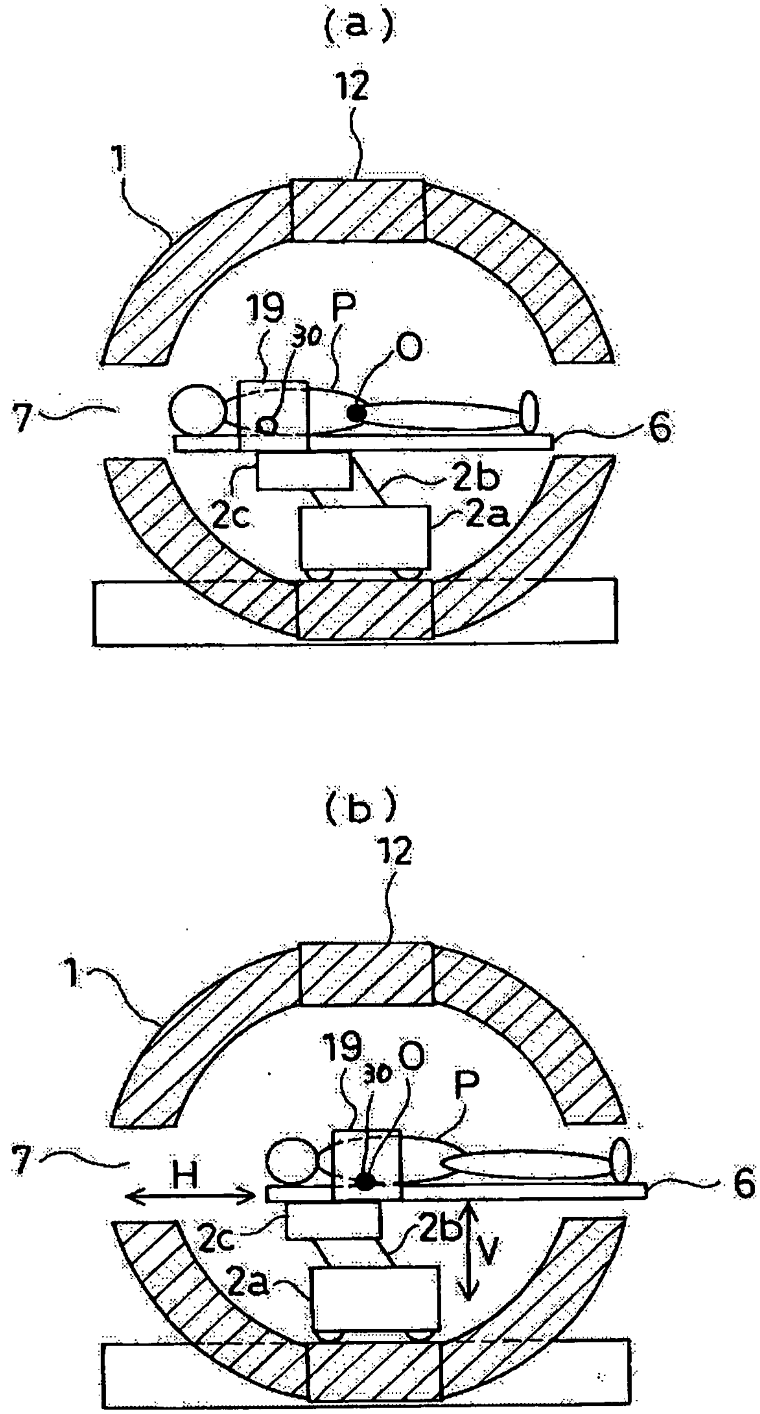
【図５】

[Fig.5]

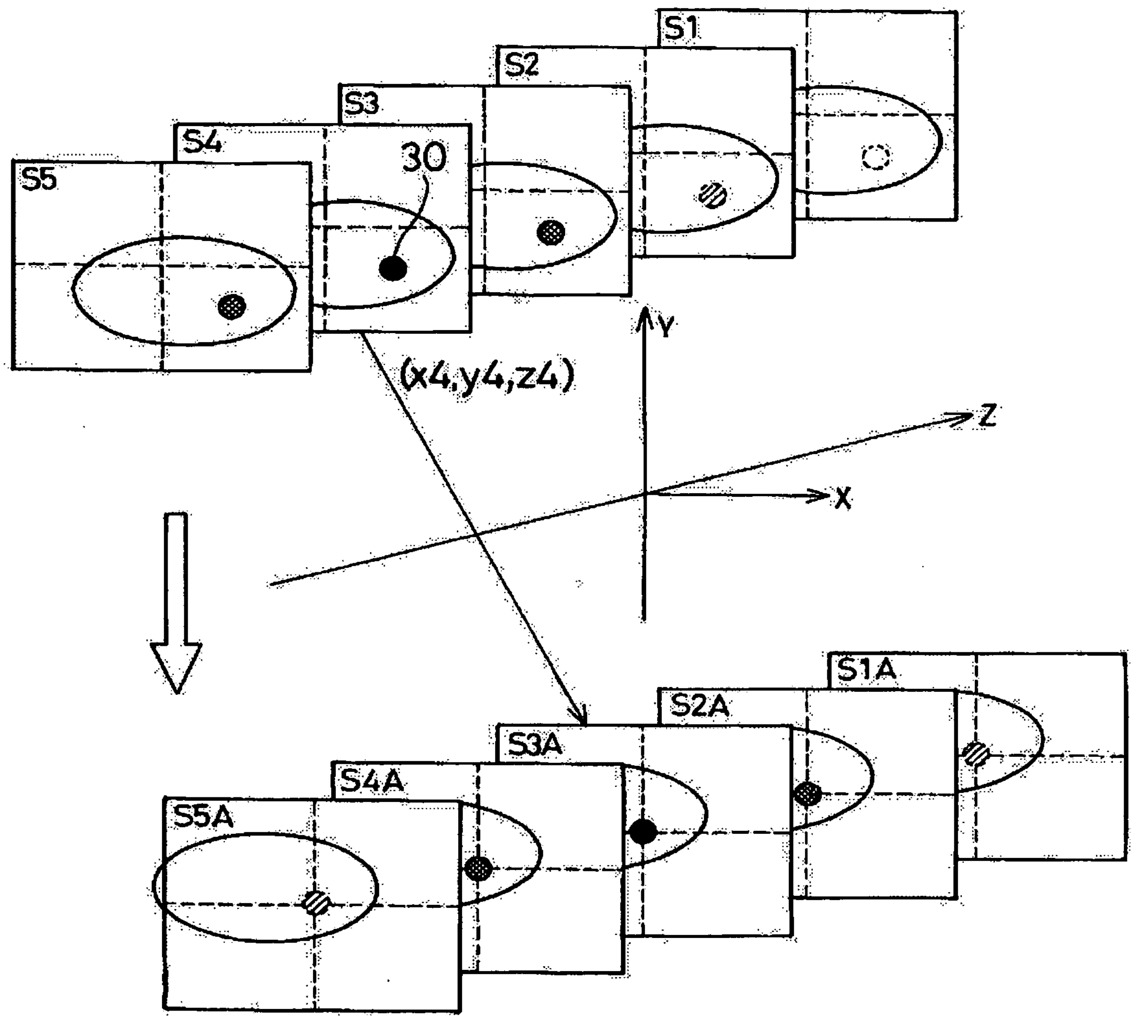


【図６】

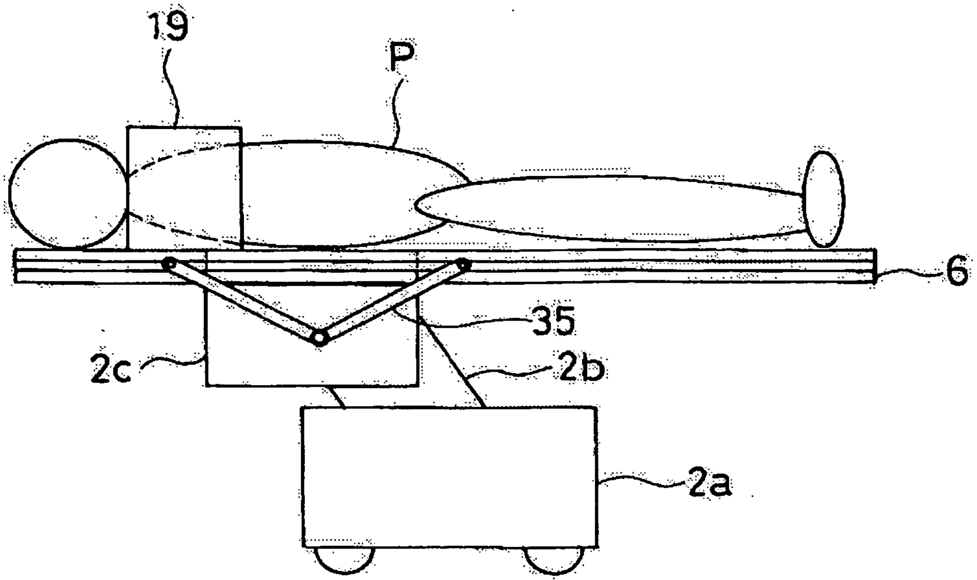
[Fig.6]



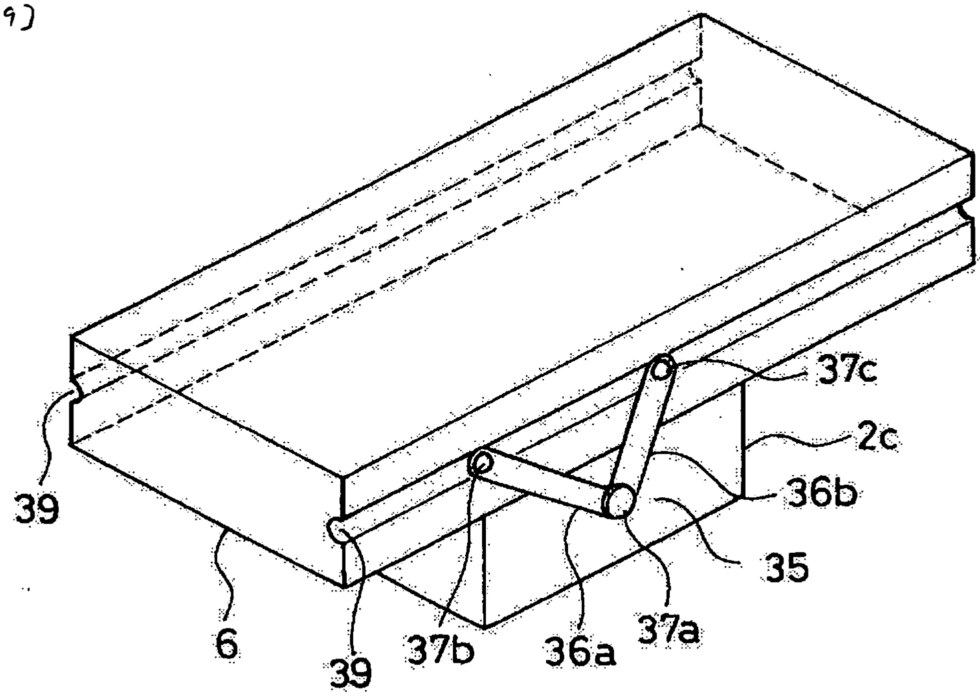
【図７】
[Fig.7]



【図８】
[Fig.8]

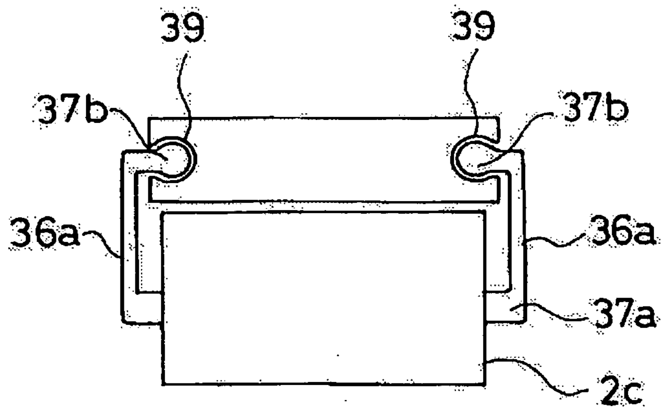


【図９】
[Fig.9]



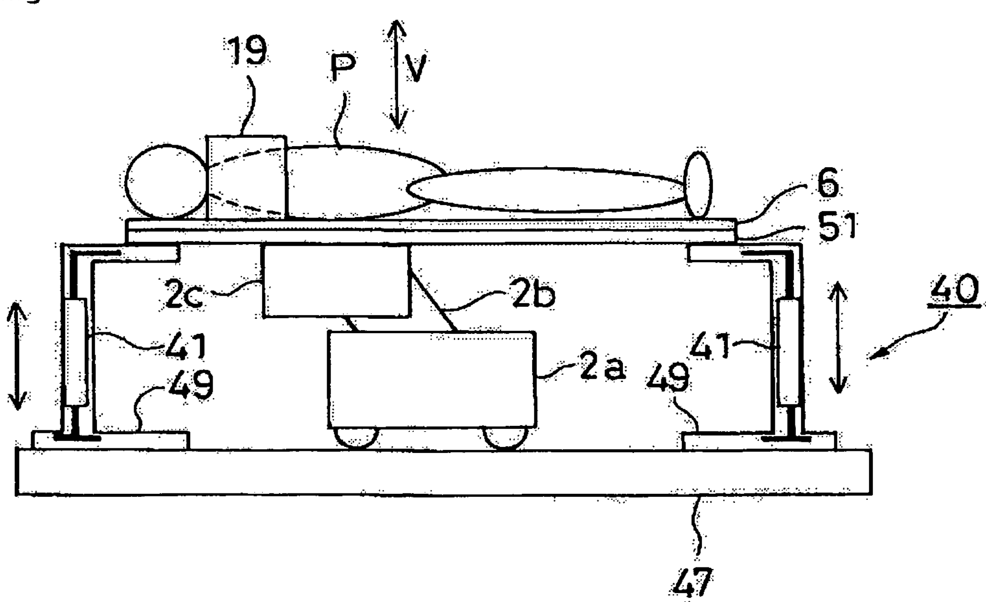
【図１０】

[Fig.10]

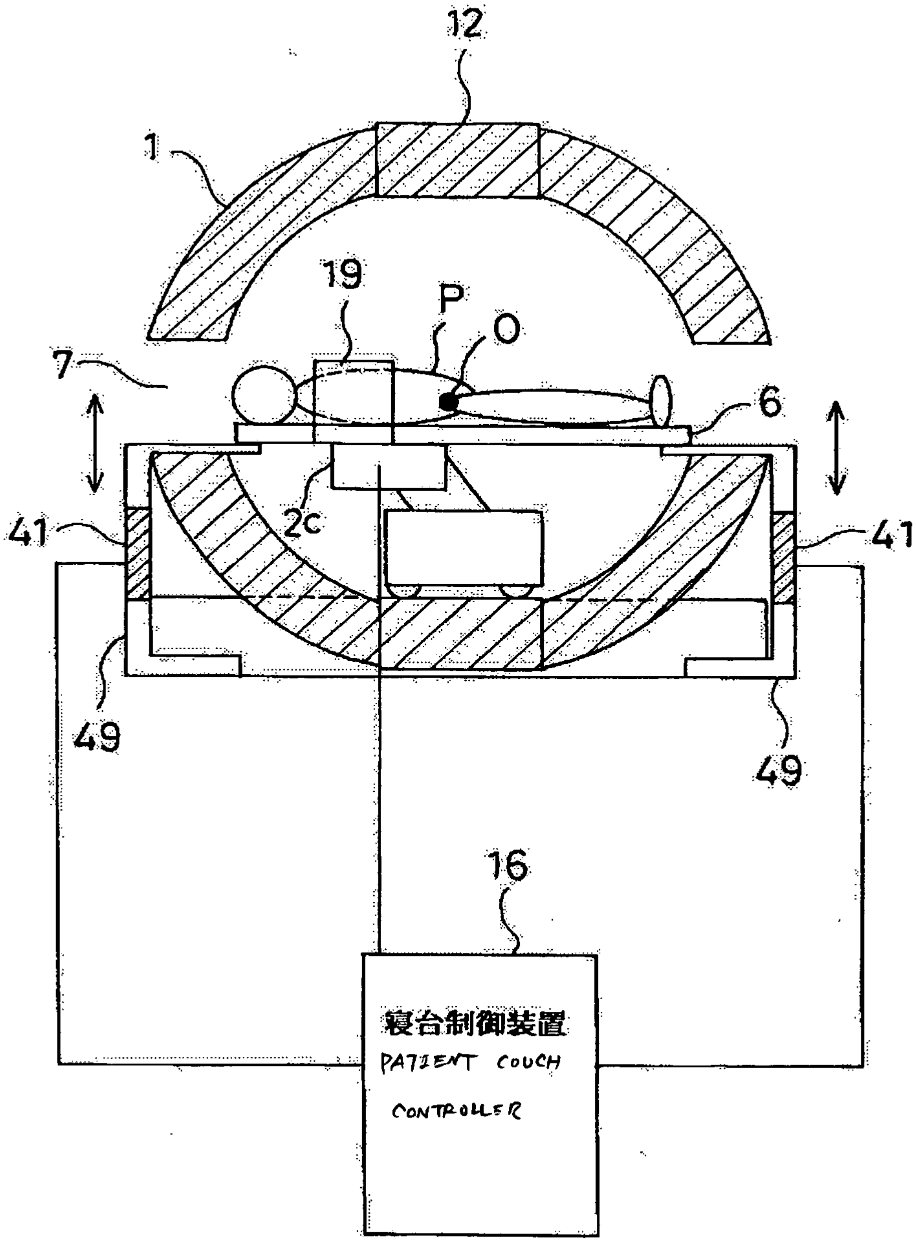


【図１１】

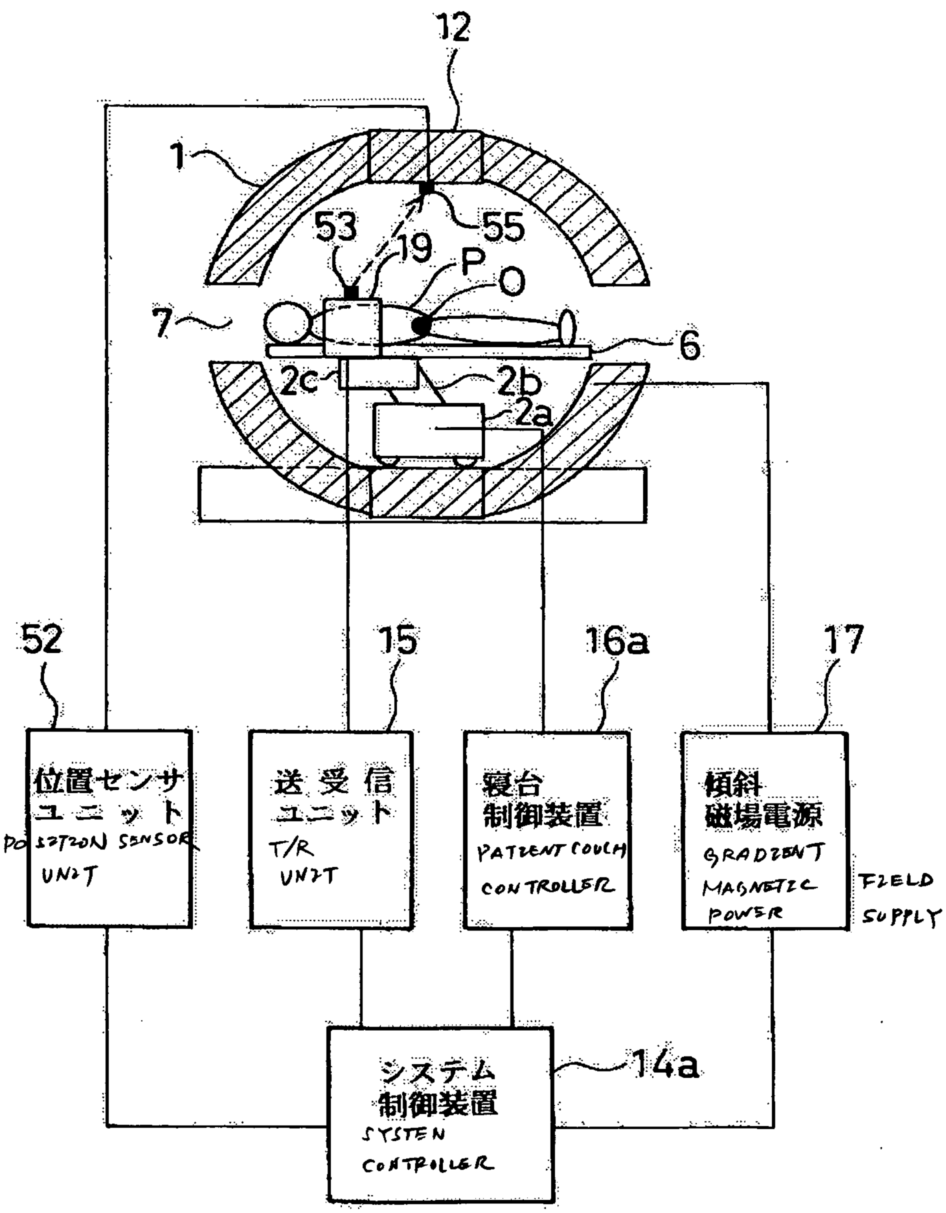
[Fig.11]



【図１２】
[Fig.12]



【図１３】
[Fig.13]


12
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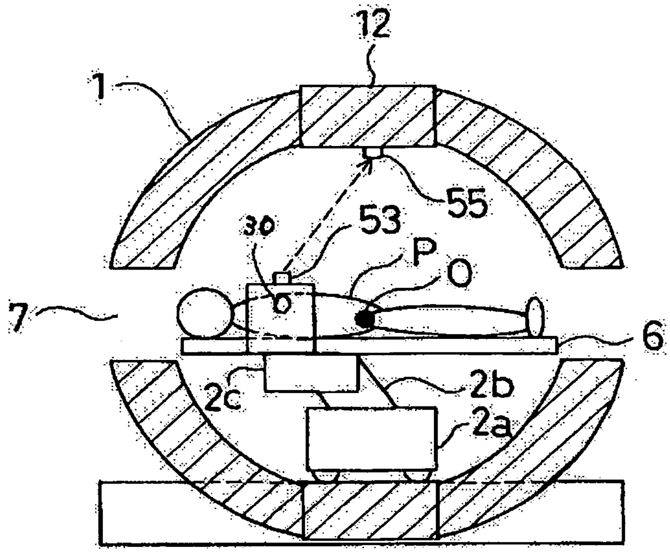
位置センサユニット
POSITION SENSOR UNIT
送受信ユニット
T/R UNIT
寝台制御装置
PATIENT COUCH CONTROLLER
傾斜磁場電源
GRADIENT MAGNETIC FIELD POWER SUPPLY
システム制御装置
SYSTEM CONTROLLER
14a

【図１４】

[Fig.14]

(a)



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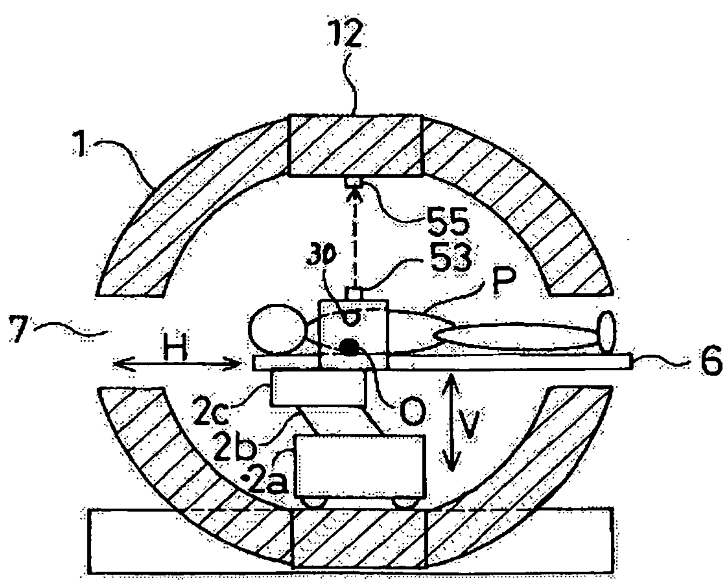
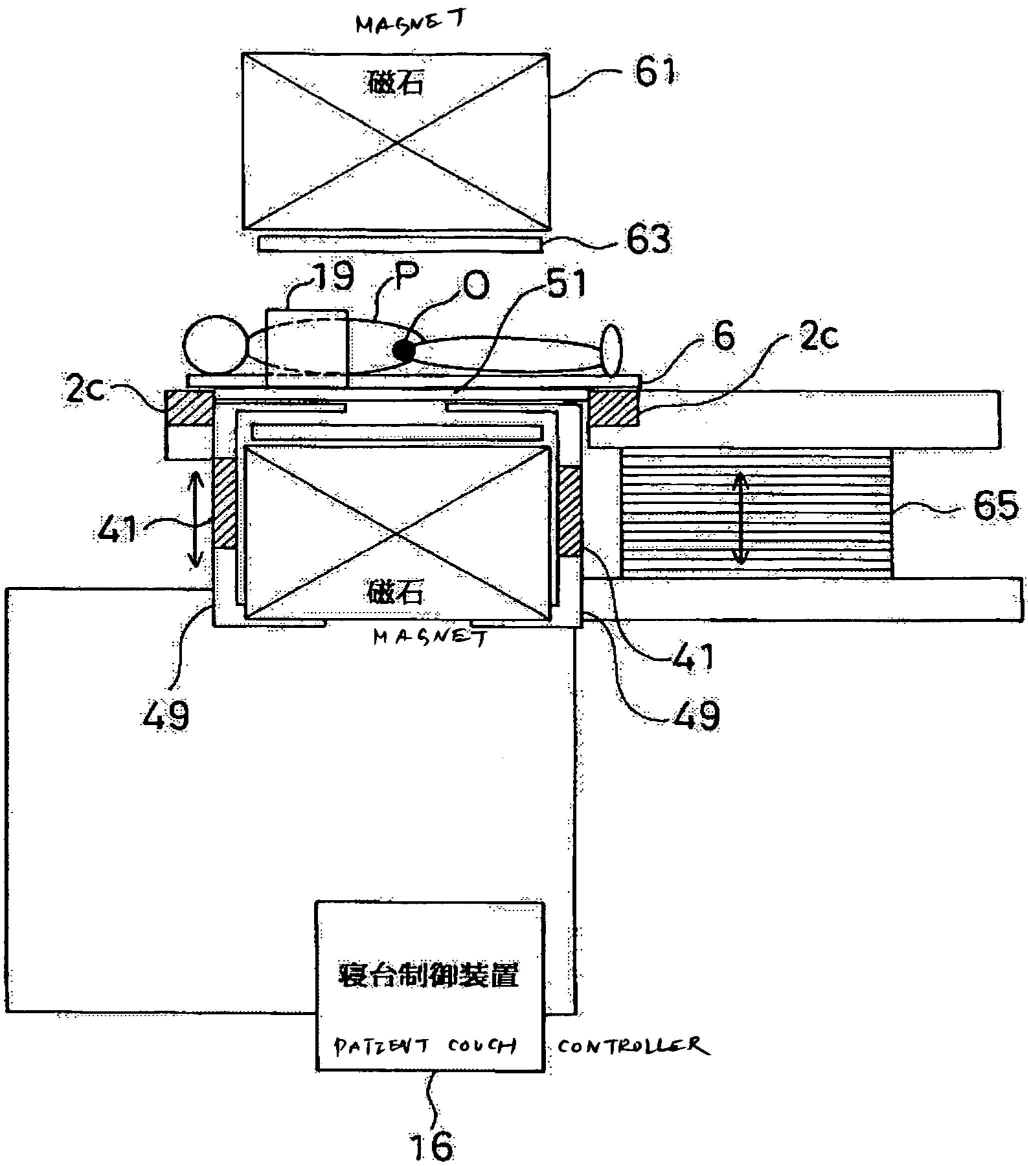


【図１５】
[Fig. 15]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MAGNET
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寝台制御装置
PATIENT COUCH CONTROLLER
16